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## A New Century for Unmanned Maritime Systems

By Thomas Kidd and Steve Ward - [October-December 2012](#)

Today's unmanned vehicles can trace their roots back to the inventor of alternating current (AC), Nikola Tesla (1856-1943). Renowned for his work with AC motors, dynamos, hydroelectric power and X-ray technology, Tesla found time to invent the world's first practical remote-controlled unmanned vessel. In 1898, Tesla was granted a U.S. patent for a "Method of and Apparatus for Controlling Mechanism of Moving Vessels or Vehicles." The patent covered "any type of vessel or vehicle which is capable of being propelled and directed, such as a boat, a balloon or a carriage." During an electrical industry trade show at Madison Square Garden in New York, Tesla publicly demonstrated his unmanned ship in a large tank of water. The historic event created some sensation about his method of using radio for command and control.

While adoption of unmanned aircraft is reaching epic proportions, unmanned maritime systems (UMS) have had slower progress. But during the next decade, a significant increase in the application of UMS is anticipated. Unmanned maritime systems, which include surface and underwater vessels, will provide enhanced capabilities to maritime administrators and operators with a significant reduction in costs. Studies predict an investment of billions of dollars will create a new generation of unmanned vehicles for various land, sea and air functions.

Applications for UMS can be classified into two main groups: commercial and governmental. Commercial applications will provide services to be sold by contractors in the course of carrying out normal business operations. Governmental applications, on the other hand, will ensure public safety and security by addressing different emergencies, issues of public interest and scientific matters.

Unmanned maritime systems are especially practical for hostile maritime environments in which deploying a crewed vessel is ill-advised. Hostile waters include high threat environments or areas contaminated by nuclear, biological or chemical agents. A key challenge for the global introduction of unmanned maritime systems is reassuring all maritime administrations and organizations that operations will integrate seamlessly into current manned maritime procedures and that UMS operations are safe.

Another critical priority for operating unmanned maritime systems is the seamless integration into the global maritime communication environment. Unmanned maritime systems will use the same equipment as manned vessels to communicate with vessel traffic control. However, due to the remote nature of human interaction, command and control are vital to operating unmanned maritime systems and will influence the eventual development of composite electromagnetic spectrum requirements.

Like many current unmanned aircraft systems, UMS command and control will be transmitted via radio frequency links between the control station and the unmanned systems. For safe operations of an unmanned maritime system, highly reliable radio communications between the UMS and the maritime control station are required to support sense and avoid functions. In the end, unrestricted and autonomous unmanned maritime systems operations will rely on critical communications.

Current traffic management relies heavily on the internationally used Automatic Identification System. AIS is a tracking system used on ships and by vessel traffic services for identifying and locating vessels by electronically exchanging data with other nearby ships and AIS base stations. The AIS provides information such as vessel unique identification, position, course and speed. New operational requirements for a future maritime data link environment will need to be developed. In some environments, additional radio frequency links called vessel traffic control relay will be required to relay communications received and transmitted by unmanned maritime systems. Reliable radio frequencies to support relayed command and control are vital and must be considered along with the "sense and avoid" support requirement. These communications are especially critical for safe navigation in high-traffic maritime areas. In the near future, international standards may be necessary to develop these types of communications.

Sense and avoid corresponds to the piloting principle "see and avoid," which is used in all situations where a vessel's operator is responsible for ensuring adequate separation from nearby vessels, terrain and obstacles, including weather. To determine appropriate spectrum characteristics related to sense and avoid, two aspects must be considered.

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First, all radio frequency equipment designed to collect raw data related to the "sense" function will have identified requirements specified by the planned radio services. For example, UMS radar equipment will operate in internationally allocated radio-determined frequency bands. The data derived by the sensors could either be directly processed inside a UMS or transmitted to the maritime control station for processing.

Second, sense and avoid system functions will be continually or regularly checked at the maritime control station for proper operation. Sense and avoid equipment parameters may also be modified by a maritime control station and transmitted back to an unmanned maritime system depending on the area, weather conditions or level of autonomy.

Bidirectional sense and avoid communications between a maritime control station and an unmanned maritime system will require two distinct sense and avoid information streams. A data downlink will allow the maritime control station to control sense and avoid operations according to local conditions, while a data uplink from a UMS to a maritime control station will provide feedback that the sense and avoid functions are operating properly.

As with current unmanned aircraft systems, the need to send sense and avoid video streams must also be considered. Similar to command and control, sense and avoid data spectrum requirements must be compliant with future standards for the safe operation of an unmanned maritime system in areas under the responsibility of maritime authorities.

Safe operations of unmanned maritime systems may also require alternative back-up communications to ensure high reliability of critical communications links. An unmanned maritime system must be able to operate in both high and low density sea environments. The vessel traffic control system may not be able to restrict an unmanned maritime system to low-density space. Larger systems are likely to be equipped with terrestrial communication capabilities such as geostationary satellite links. However, the impact of latency on unmanned maritime systems' command-and-control systems will be critical when considering the safety of operations.

While today's 21st century UMS technology has developed from Nikola Tesla's 19th century vision, it remains an emerging technology. Many challenges, including the operational complexities of managing radio frequency electromagnetic spectrum, must be overcome for unmanned maritime systems to become commonplace in commercial and governmental applications. The DON Chief Information Officer maintains continual national and international engagement in electromagnetic spectrum and maritime regulatory bodies to ensure the success of naval UMS for our Sailors and Marines.

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